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SPECTROSCOPY.—*Spectrum regularities for scandium and yttrium.*[1] W. F. MEGGERS, Bureau of Standards.

Scandium and yttrium, with atomic numbers 21 and 39 respectively, occupy positions in the third column of the periodic table of the chemical elements following calcium and strontium in the second column which in turn follow potassium and rubidium in the first column. Whereas the arc spectra and some of the spark spectra characterizing the elements in the first two columns of the table have received fairly complete and satisfactory interpretations, the results for scandium and yttrium are still incomplete and uncertain. The writer has given some attention to the arc and spark spectra of these two elements, and although the final classifications will be postponed until supplementary investigations on Zeeman effect are completed, the main features of these spectra are sufficiently well established to be presented at this time.

Tables 1, 2, 3, and 4 contain, respectively, examples of multiplets in the arc and spark spectra of scandium, and the arc and spark spectra of yttrium. In these tables the types of combining spectral terms or energy levels, together with the separations of the sub-levels, are indicated at the margin of the multiplets. The individual spectral lines are represented by their observed wave lengths, and the corresponding wave numbers (waves per cm. in vacuo). Estimated relative intensities of the lines, and for scandium King's[2] temperature classes, appear above the wave lengths. The subscripts to the term symbols represent inner quantum numbers. Different spectral systems are conveniently distinguished by attaching to the term symbol a superscript

[1] Published by permission of the Director of the Bureau of Standards of the Department of Commerce.

[2] King, Astrophys. Journ. 54: 28. 1921.

corresponding to the maximum or permanent multiplicity attainable, but since each of the succeeding tables refers to one system only, the superscripts have been omitted.

The results published by Moore[3] for the Zeeman effect of the yttrium and spark lines listed in tables 3 and 4 are reproduced in tables 5 and 6 where they are compared with the patterns calculated according to Landé.[4] The observed magnetic separations have been reduced to terms of the separation of a normal triplet as a unit. The parallel components, enclosed in parentheses, are followed by the perpendicular components. In some cases the calculated patterns are rather complex so that only the stronger components—those likely either to be resolved or to affect the measurements—are expressed in decimal form, the remaining weaker ones being indicated by asterisks. When two or more components are given the most intense one is distinguished by bold face type.

The Zeeman effect data in tables 5 and 6 are regarded as confirming most of the multiplets for arc and spark spectra of yttrium listed in tables 3 and 4. No Zeeman patterns have as yet been published for scandium lines, but special attention is directed to the close correspondence of spectral structures of scandium and yttrium which is evident from a comparison of tables 1 and 2 with tables 3 and 4, respectively. On account of this intimate resemblance it may be predicted that when the magnetic resolutions of scandium lines are observed the classified lines will be found to have the same patterns as those already found for the corresponding lines in the yttrium spectra.

1. *Arc spectrum of scandium* (ScI). Practically all of the strong arc lines of scandium can be arranged in combinations of doublet- or quartet-system terms. Most of these have already been published by Catalan[5] but his doublet term designations are probably in error. Professor H. N. Russell[6] suggested the correct arrangement of terms to me last year, and similar corrections supported by observations of the absorption spectrum have since been made by Gieseler and Grotrian.[7] The lowest level in the neutral atom is a doublet with separation of 168.35 wave numbers. This was regarded by Catalán as a P term but is more likely of the D type. The spectra of scandium are

[3] Moore, Astrophys. Journ. **28**: 1. 1908.

[4] Landé, Zeit. f. Physik. **15**: 189. 1923.

[5] Catalán, Anales Soc. Espan. Fis. y Quim. **20**: 606. 1922. Ibid. **21**: 464. 1923.

[6] Russell, In a letter addressed to the author, December 21, 1923. Astrophys. Journ. In Press. 1924.

[7] Gieseler and Grotrian, Zeit. f. Physik. **25**: 342. 1924.

almost identical in structure with those of yttrium for which some Zeeman patterns have been published by Moore and the proof presented below that the normal state of the neutral atom of yttrium contains the last electron in a 3_2 orbit may, therefore, be considered to apply to scandium as well as to yttrium. Table 1 contains some examples of multiplets in the doublet system of ScI. The wave lengths and estimated intensities (scale 1 to 100) are from new determinations made at the Bureau of Standards.

TABLE 1.—DOUBLETS IN THE SPECTRUM OF ScI

	D_2	168.35	D_1
	10, II		
F_4	3019.33		
	33110.27		
124.63			
	3, II		8, II
F_3	3030.74		3015.35
	32985.64		33154.02
	15, IIA		4, IA
P_2	3273.64		3255.69
	30538.32		30706.66
133.57			
			10, IIA
P_1			3269.91
			30573.09
	60, II		
F_4	3911.81		
	25556.39		
140.07			
	10, II		40, II
F_3	3933.37		3907.49
	25416.32		25584.64
	70, II		15, I
D_2	4023.69		3996.61
	24845.85		25014.18
147.98			
	10, I		50, II
D_1	4047.79		4020.40
	24697.89		24866.17
	30, I		20, I
$D_{2,1}$	4082.40		4054.54
	24488.52		24656.80

TABLE 1.—DOUBLETS IN THE SPECTRUM OF ScI—*Continued*

	20, IA	
F_4	4779.35	
	20917.54	
53.08		
	5, IA	12, IA
F_3	4791.50	4753.16
	20864.46	21032.78
	15, IIA	4, IIA
P_2	5349.71	5301.94
	18687.41	18855.78
144.76		
		10, IIA
P_1		5342.96
		18711.02
	6, IA	1, IIA
D_3	6258.97	6193.66
	15972.65	16141.09
44.20		
	3, IIA	6, IA
D_2	6276.33	6210.86
	15928.49	16096.84
	50, IA	10, IIA
D_3	6305.69	6239.40
	15854.31	16022.77
0.9		
	10, IA	20, IA
D_2	6305.99	6239.78
	15853.56	16021.79
	6, IA	2, IIA
D_3	6413.37	6344.84
	15588.12	15756.50
83.96		
	1, IIA	5, IA
D_2	6448.10	6378.83
	15504.17	15672.54

2. *Spark spectrum of scandium* (ScII). The wave lengths and intensities of scandium spark lines classified in table 2 are from unpublished values determined by the writer, while the temperature classes and enhanced symbols are from King's work. The ultra-violet multiplet of six lines (2540.87—2563.23A) was properly named by Popow[8] in 1914. In 1922, Catalán published six additional multiplets but the types of terms were misnamed in three of these. The correct identification of the terms was suggested to me by Professor

[8] Popow, Ann. d. Physik. 45: 163. 1914.

TABLE 2.—TRIPLETS IN THE SPECTRUM OF ScII

	D_3	109.97	D_2	67.65	D_1
	60, II				
F_4	3613.84u_1				
	27663.56				
238.86					
	30, III		50, II		
F_3	3645.31		3630.76u_2		
	27424.70		27534.65		
158.72					
	3, III		25, III		40, II
F_2	3666.54		3651.80		3642.79
	27265.96		27376.01		27443.68
	50, II		20, II		
D_3	3572.53		3558.55		
	27983.40		28093.37		
139.82					
	20, II		35, II		20, II
D_2	3590.48		3576.35		3567.70
	27843.53		27953.55		28021.25
103.52					
			20, II		30, II
D_1			3589.64		3580.94
			27850.01		27917.73
	20, III		10, III		3, IV
P_3	3372.14		3359.68		3352.08
	29646.24		29756.24		29823.95
81.80					
			15, III		10, III
P_1			3368.94		3361.26
			29674.44		29742.20
5.94					
					12, III
P_0					3361.94
					29736.23
	10		5		1
P_2	2552.38		2545.24		2540.87
	39167.41		39277.21		39344.74
230.39					
			9		6
P_1			2560.26		2555.84
			39046.84		39114.33
112.74					
					8
P_0					2563.23
					39001.59

TABLE 2.—TRIPLE *s* IN THE SPECTRUM OF ScII—*Continued*

	F_4	104.21	F_3	80.68	F_2
	40, III E		5, V E		
F_4	4374.46		4354.60		
	22853.57		22957.79		
238.86					
	2		30, III E		6, IV E
F_3	4420.66		4400.38		4384.80
	22614.72		22718.92		22799.65
158.72					
			3, V E		20, III E
F_2			4431.35		4415.55
			22560.17		22640.91
	60, III E		8, IV E		1
D_3	4314.09		4294.77		4279.95
	23173.39		23277.60		23358.20
139.82					
			50, III E		10, IV E
D_2			4320.73		4305.71
			23137.76		23218.43
103.52					
					40, III E
D_1					4325.00
					23114.93
	P_2	52.94	P_1	27.46	P_0
	25, V E				
D_3	6245.64				
	16006.73				
139.82					
	8		20		
D_2	6300.70		6279.74		
	15866.87		15919.84		
103.52					
	1		8		15
D_1	6342.08		6320.86		6309.90
	15763.34		15816.28		15843.74
	25, V E		15, V E		
P_2	5657.89		5640.99		
	17669.55		17722.48		
81.80					
	12, V E		9, V E		8, V E
P_1	5684.21		5667.16		5658.35
	17587.72		17640.65		17668.10
5.94					
			10, V E		
P_0			5669.05		
			17634.75		

Russell, and although as stated above there are as yet no published Zeeman-effect data for scandium, comparison with the spectral structure of YII for which such data exist, and general consideration of the various rules which govern multiplet structures, leave no further doubt as to the naming of these terms.

The lowest energy level in the ionized scandium atom is represented by the D term with separations of 67.65 and 109.97; the *raies ultimes*,[9] marked u_1, and u_2 occur in a DF combination.

Lines probably belonging to the singlet spectral system are recognized in the scandium spark but they have not yet been classified. The presence of singlet and triplet systems in ScII makes this spectrum resemble the arc spectrum of the preceeding element, calcium, in accordance with the displacement law of Kossel and Sommerfeld.

3. *Arc spectrum of yttrium* (YI). Since the spectra of yttrium are expected to be similar in structure to those of scandium it is not surprising to find that most of the stronger arc lines of yttrium originate in combinations of doublet terms. The lowest level in the spectrum of neutral yttrium is a doublet D term with the separation 530.35. No results of temperature classification or of absorption observations in this spectrum have been published but the fact that many of the lines involving this D level appear strongly enhanced in the Mt. Wilson Observatory map of the sun-spot spectrum is good evidence that it is the lowest level. It is strictly analogous to the doublet term established by the absorption observations of Gieseler and Grotrian to be the lowest level in ScI. A partial list of the combinations of this low D level with other terms in the yttrium arc spectrum is given in table 3, and the data for Zeeman effect of these lines are reproduced in table 5.

TABLE 3.—DOUBLETS IN THE SPECTRUM OF YI

	D_3	530.35	D_2
	20		3
P_2	3620.94		3552.69
	27609.29		28139.69
314.99			
			10
P_1			3592.91
			27824.70

[9] de Gramont, Comptes Rendus **171**: 1106. 1920.

TABLE 3.—DOUBLETS IN THE SPECTRUM OF YI—*Continued*

	30	5
P_2?	4128.32	4039.83
	24216.13	24746.53
47.79		
		8
P_1		4047.65
		24698.74
	8	8
P_2	4174.14	4083.71
	23950.31	24480.64
349.54		
		20
P_1		4142.87
		24131.10
	20	
F_4	4102.38	
	24369.26	
380.91		
	10	20
F_3	4167.52	4077.39
	23988.35	24518.58
	10	
F_4	4674.84	
	21385.16	
386.99		
	5	10
F_3	4760.99	4643.70
	20998.17	21528.53
	6	15
D_3?	6402.02	6191.73
	15615.75	16146.13
80.08		
	15	10
D_2?	6435.03	6222.58
	15535.66	16066.05
	4	3
D_3?	6793.72	6557.44
	14715.50	15245.83
296.82		
	3	6
D_2?	6933.56	6687.57
	14418.70	14948.98

4. *Spark spectrum of yttrium* (YII). Two multiplets of the type D^3P^3 were published by Popow[10] in 1914. These and additional groups in the triplet system are collected in table 4. So far as these groups are concerned, it is evident from tables 2 and 4 that the spectrum of YII is exactly analogous to that of ScII. The sublevels of yttrium terms are more widely separated than those of scandium and the corresponding multiplets are displaced toward the red. Three sets of P terms having been found in ScII at least as many would be expected in YII, but in the latter case the multiplets involving the low P level

TABLE 4.—TRIPLETS IN THE SPECTRUM OF YII

	D_3	404.8	D_2	204.9	D_1
	100				
F_4	3710.30u_1				
	26944.37				
861.6					
	20		50		
F_3	3832.87		3774.33u_2		
	26082.76		26487.26		
305.4					
	4		10		30
F_2	3878.27		3818.37		3788.69
	25777.44		26181.79		26386.90
	50		20		
D_3	3600.72		3548.99		
	27764.36		28169.01		
484.0					
	20		30		10
D_2	3664.59		3611.05		3584.51
	27280.44		27684.88		27889.88
134.7					
			10		20
D_1			3628.70		3601.91
			27550.26		27755.19
	20		6		3
P_2	4309.61		4235.71		4199.28
	23197.44		23602.16		23806.92
870.9					
			15		8
P_1			4398.03		4358.72
			22731.10		22936.10
331.3					
					10
P_0					4422.60
					22604.80

[10] Popow, Ann. d. Physik. **45**: 163. 1914.

TABLE 4.—TRIPLETS IN THE SPECTRUM OF YII—*Continued*

	20		8		5
P_2	3242.28		3200.25		3179.40
	30833.64		31238.58		31443.37
159.5					
			10		8
P_1			3216.67		3195.61
			31079.07		31283.93
75.3					
					8
P_0					3203.32
					31208.64
	F_4	415.4	F_3	324.9	F_2
	10		3		
F_4	5087.42		4982.12		
	19650.92		20066.18		
861.6					
	1		10		3
F_3	5320.77		5205.71		5119.10
	18789.04		19204.36		19529.26
305.4					
			2		8
F_2			5289.81		5200.41
			18899.02		19223.93
	50		5		1
D_3	4883.69		4786.57		4713.26
	20470.62		20885.98		21210.85
484.0					
			30		10
D_2			4900.11		4823.32
			20402.05		20726.85
134.7					
					30
D_1					4854.88
					20592.10
	P_2	79.8	P_1	−79.8	P_0
	20				
D_3	6613.74				
	15115.87				
484.0					
	5		15		
D_2	6832.47		6795.40		
	14631.96		14711.78		
134.7					
	?		5		10
D_1	6895.99		6858.22		6895.99
	14497.19		14577.04		14497.19

TABLE 4.—TRIPLETS IN THE SPECTRUM OF YII—*Continued*

P_2	10708.4	10628.6	
870.9			
P_1	9837.5	9757.8	9837.5
331.3			
P_0		9426.5	

would probably appear in the red or infra-red. A special search for these was made with sensitized photographic plates, and a group of enhanced lines was found between 6613.74 and 6895.99A. These have been arranged in a PD multiplet which, if correct, indicates that P_0 and P_2 are coincident. The combination of this level with the higher P level (separations 331.3 and 870.9) should give a multiplet in the infra-red. This one, however, is just outside the region which is accessible to photography, so there is at present no way to verify the abnormal P term. The remaining terms are all established by the Zeeman-effect data collected in table 6. The lowest level in ionized yttrium is the D term with separations 204.9 and 404.8; the *raies ultimes*, marked u_1 and u_2 appear in a DF combination.

In addition to the triplet-system multiplets here presented, two pairs have been recognized as combinations between the triplet and singlet systems. These are 3747.55, 3776.58A (P^1D^3), and 3950.35, 3982.60A (D^1D^3). The relative values of other singlet terms have not been satisfactorily arranged as yet. Extended results of investigations on the spectra of scandium and yttrium will appear later in Scientific Papers of the Bureau of Standards.

TABLE 5.—ZEEMAN EFFECT FOR YI

Terms	λI.A.	*Obs.*	*Calc.*
D_3P_2	3552.69	(0.78) ——	(0.00, **0.80**) 0.53, **1.06**, 1.60
D_2P_1	3592.91	(0.00) 0.79	(0.07) 0.73, **0.87**
D_3P_2	3620.94	(0.00) 1.00	(**0.07**, 0.20) **1.00**, 1.14, **
D_3P_2	4039.83	(0.00) 1.37	(0.00, **0.80**) 0.53, **1.06**, 1.60
D_2P_1	4047.65	(0.00) 0.75	(0.07) 0.73, **0.87**
D_3P_2	4128.32	(0.25) 1.10	(**0.07**, 0.20) **1.00**, 1.14, **
D_3P_2	4083.71	(0.73) 0.55, **0.98**, 1.55	(0.27, **0.80**) 0.53, **1.06**, 1.60
D_2P_1	4142.87	(0.00) 0.80	(0.07) 0.73, **0.87**
D_3P_2	4174.14	(0.00) 1.09	(**0.07**, 0.20) **1.00**, 1.14**
D_2F_3	4077.39	(0.00) 1.06	(**0.03**, 0.09)** 0.89, **0.94**
D_2F_4	4102.38	(0.00) 1.07	(**0.03**, 0.09*) **1.00**, 1.06, 1.12***
D_2F_3	4167.52	(0.52) 1.05	(*0.51, **0.86**)* 0.69, **1.03**, 1.37*
D_2F_3	4643.70	(0.00) 0.89	(**0.03**, 0.09)** 0.89, **0.94**
D_2F_4	4674.84	(0.00) 1.05	(**0.03**, 0.09*) **1.00**, 1.06, 1.12***

TABLE 6.—ZEEMAN EFFECT FOR YII

Terms	λI.A.	*Obs.*	*Calc.*
D_2P_2	3200.25	(0.60) 1.34	(0.33, **0.67**) 0.83, **1.17**, **1.50**, 1.83
D_2P_1	3216.67	(0.00) 0.98	(**0.00**, 0.33) **0.83**, 1.17, 1.50
D_2P_3	3242.28	(0.00) 1.16	(**0.00**, 0.17*) **1.00**, 1.17, 1.33**
D_2D_3	3548.99	(0.00) 1.46	(**0.00**, 0.17*) **1.33, 1.50, **1.67**
D_1D_2	3584.51	(**0.00**, 0.65) 0.47, 1.15, **1.81**	(0.00, **0.67**) 0.50, 1.17, **1.83**
D_2D_3	3600.72	(0.00) 1.29	(0.00) 1.33
D_1D_1	3601.91	(0.00) 0.54	(0.00) 0.50
D_2D_2	3611.05	(0.00) 1.14	(0.00) 1.17
D_2D_1	3628.70	(**0.00**, 0.58) 0.55, 1.12, **1.68**	(0.00, **0.67**) 0.50, 1.17, **1.83**
D_2D_2	3664.59	(0.00) 1.52	(**0.00**, 0.17*) **1.33, 1.50, **1.67**
D_2F_4	3710.30	(0.00) 1.09	(**0.00**, 0.08**) **1.00**, 1.08, 1.17****
D_2F_3	3774.33	(0.00) 1.00	(**0.00**, 0.08*) **0.92**, 1.00, 1.17*
D_1F_2	3788.69	(0.00) 0.89	(**0.00**, 0.17) 0.50, 0.67, **0.83**
D_2F_2	3818.37	(0.38, **0.77**) 0.37, **0.74**, **1.14**, 1.52	(0.50, **1.00**) 0.17, **0.67**, **1.17**, 1.67
D_2F_1	3832.87	(0.61) 1.17	(*0.50, **0.75**) **1.08, **1.33****
D_2P_2	4235.71	(0.31, **0.62**)—	(0.33, **0.67**) 0.83, **1.17**, **1.50**, 1.83
D_2P_2	4309.61	(0.00) 1.16	(**0.00**, 0.17*) **1.00**, 1.17, 1.33**
D_1P_1	4358.72	(0.96) 0.47, 1.44	(1.00) 0.50, 1.50
D_1P_0	4422.60	(0.00) 0.47	(0.00) 0.50
F_2D_1	4854.88	(0.00) 0.80	(**0.00**, 1.17) 0.50, 0.67, **0.83**
F_4D_3	4883.69	(0.00) 1.08	(**0.00**, 0.08**) **1.00**, 1.08, 1.16****
F_3D_3	4900.11	(0.00) 0.96	(**0.00**, 0.08*) **0.92**, 1.00, 1.08**
F_4F_4	5087.42	(0.00) 1.17	(0.00) 1.25
F_2F_2	5200.41	(0.00) 0.65	(0.00) 0.67
F_3F_3	5205.71	(0.00) 1.03	(0.00) 1.08

ZOOLOGY.—*New species of* Ferrissia *from Lower California.* BRYANT WALKER. (Communicated by PAUL BARTSCH.)

I am indebted to Dr. Paul Bartsch of the U. S. National Museum for the opportunity of examining a small lot of Ancylids collected by him in a small pool two and one-half miles inland from San José del Cabo, Lower California. It was found that two very distinct species were represented in the collection, both of which belong to *Ferrissia s. s.* The occurrence of the typical group of this genus so far south was quite a surprise as all of the Mexican species, so far as they have been examined as to apical sculpture, belong to the subgenus *Lael-*

papex. *Ferrissia s. s.*, however, is found all along the west coast of the United States, and the colony at San José, no doubt, represents a southern extension of the northern fauna.

Ferrissia bayacalifornica, n. sp. (fig. 1)

Shell pale corneous, thin, obovate, the greatest width being at about the anterior third of the length; anterior margin broadly rounded; posterior margin regularly rounded, but slightly compressed on the right side; lateral margins about equally curved, the left somewhat more so; apex acute, scarcely depressed at the tip, situated at about one mm. from the posterior margin and decidedly turned to the right, radially striate; anterior slope nearly straight, slightly curved towards the apex; posterior slope oblique and nearly straight below the projecting apex; left lateral slope slightly, but regularly

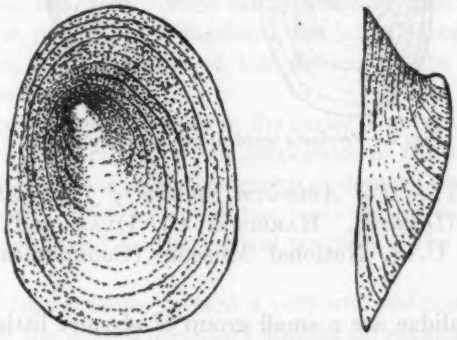

Fig. 1.—*Ferrissia bayacalifornica*, much enlarged.

curved from the apex to the lateral margin; right lateral slope slightly incurved at the base of the apex and thence obliquely straight to the lateral margin; surface with fine and regular growth-lines and very faint, scarcely perceptible indications of radial rippling on the anterior slope towards the margin.

Length 4.75; width 3.4; alt. 1.4 mm.

Type.—No. 264600, U. S. National Museum. Paratypes in Coll. Walker (no. 77862).

This species in its obovate shape and acute apex differs very distinctly from any of the described species of *Ferrissia s. s.*

Ferrissia occidentalis, n. sp. (fig. 2)

Shell pale greenish horn color, thin, nearly oval, slightly wider anteriorly anterior and posterior margins regularly rounded; lateral margins about equally curved; apex very obtuse, situated at the posterior fourth of the length, somewhat turned to the right, radially striate; anterior slope regularly but not strongly curved from the apex to the anterior margin; posterior slope oblique and slightly incurved; left lateral slope slightly convex; right lateral slope somewhat incurved; surface with very fine and regular growth-lines and without radial sculpture.

Length 4; width 2.5; alt. 1.25 mm.

Type.—No. 361553, U. S. National Museum. Paratypes in Coll. Walker (no. 77863).

This species differs from the preceding in its smaller size, oval shape and obtuse apex and these features serve to distinguish it from any of the other described species.

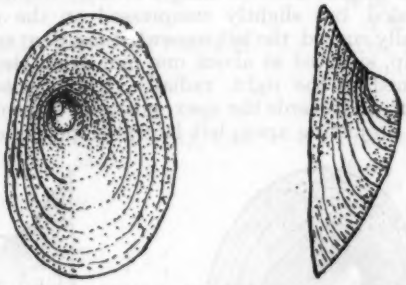

Fig. 2.—*Ferrissia occidentalis*, much enlarged.

ENTOMOLOGY.—*The American Species of Thaumalidae (Orphnephilidae) (Diptera)*. HARRISON G. DYAR and RAYMOND C. SHANNON, U. S. National Museum (Communicated by S. A. ROHWER).

The Thaumalidae are a small group of obscure little flies, usually found in hilly, heavily wooded country around the moss-covered banks of very shallow streams and springs. They have been very rarely collected in North America, our previous records being confined to New York State only.

In 1913 Bezzi pointed out[1] that the single known American species of this family, which had previously been considered conspecific with the European *Orphnephila testacea* Ruthé (See L. G. Saunders[2]), was distinct, and for it proposed the name *Thaumalea americana*. Several additional American species are at present represented in the collection of the U. S. National Museum.

The family Thaumalidae holds a unique place in the classification of the nematocerous Diptera. Its exact position is uncertain, because of a number of peculiar structural characters.

The wing venation according to the Comstock-Needham system is as follows: The costa continues around the wing to its tip, where it is

[1] Boll. Lab. Zool. R. Scuola d'Agr. Portici 7: 227–266. 1913.

[2] Ann. Mag. Nat. Hist. ser. 9, 11: 631–640. 1923.

much weaker beyond R_{4+5} (third longitudinal); the subcosta is usually weak, sometimes evanescing before its tip; the Sc-R cross-vein is placed at about the middle of the subcostal; R_1 joint costal beyond middle of wing; the radial sector forks about opposite the tip of subcostal; with branch R_{4+5} forking a short distance beyond; R_2 joins R_1 a short distance beyond the fork of R_{4+5} and appears as a cross-vein, thus making a small first R_1 cell; R_3 and R_{4+5} are nearly parallel and extend to tip of wing; R-M cross-vein is near the base of the forking of R_{4+5}; the media is reduced to a single branch; M-Cu cross-vein present, making a second basal cell; Cu_1 and Cu_2 both present; anal vein absent.

The antenna has been somewhat indefinitely described. It consists of a scape, pedicel, and flagellum, the latter being very compact and arista-like, but composed of ten distinct joints, the basal two rather large and globose.

A peculiar phenomenon occurs in the males of several of the families of Nematocera. Shortly after the emergence of the adult, the tip of the abdomen beyond the seventh segment undergoes a rotation through an angle of 180°. The Thaumalidae, however, do not undergo this change, as is evidenced by the ventral position of the side-pieces and claspers.

The adults, furthermore, present a very unusual condition by lacking spiracles in the second and third abdominal segments.

KEY TO AMERICAN SPECIES OF THAUMALEA

Subcostal vein of wing obsolete on its apical part.....1. *pluvialis*, n. sp.
Subcostal vein distinct apically where it joins costa.
Darkly colored species, the mesonotum dark brown; abdomen and pleurae nearly black.
Male clasper with two terminal claws; terminal abdominal hairs long; tenth sternites parallel sided.....2. *americana* Bezzi.
Male clasper with about six terminal claws; terminal abdominal hairs shorter and spine-like; tenth sternites spatulate at tip.....3. *johannis*, n. sp.
Pale colored species, the mesonotum and pleurae light testaceous; abdomen brown.....4. *elnora*, n. sp.

1. **Thaumalea pluvialis,** new species.

A dark brown medium sized species. Mesonotum thickly clothed with very small hairs; margin of scutellum with several rows of minute setae. Legs dark brown. Wings strongly infuscated; in addition to the usual villae, clothed with numerous hair-like setulae. Subcosta faint beyond Sc-R cross vein, its apex entirely evanescent; R_2 about five times its length distant from base of fork of R_{4+5}; R_3 slightly curved, nearly parallel with R_{4+5}. Halteres and abdomen dark brown. Length 2.5 mm.

Male hypopygium. Ninth segment convex and chitinized dorsally, not enclosing the side-pieces, which fit in beneath it. Side piece ovate, a little longer than wide, the tip notched for the reception of the clasper; many spiny

setae at the tip. Clasper slender, parallel sided, a little swollen in the middle, with about 14 terminal claws and three stout spines, the latter inserted in an oblique row on the outer fourth of the clasper. A triangular weakly chitinized piece at base of side piece and not as long as its width may represent the tenth sternites.

Types, two males, no. 27460, U. S. Nat. Mus.; Prince Rupert, British Columbia, Canada, June 17, 1919 (*H. G. Dyar*).

2. **Thaumalea americana** Bezzi.

Male hypopygium. Ninth segment covering the hypopygium, the paired flaps beyond it with long setae. Side piece conical, as broad as long, strong excavate at tip for the insertion of the clasper, with coarse hairs outwardly and beneath. Clasper short, tapering, with two terminal claws. Tenth sternites with triangular base, curved, parallel-sided and rounded tips.

Our localities for this species are as follows:

NEW YORK: Ithaca, August 30, 1901 (*O. A. Johannsen*).

PENNSYLVANIA: Pequea, August 31, 1924 (*R. C. Shannon*).

WEST VIRGINIA: Cheat Mountain Cave, File Creek (*D. H. Clemons*).

3. **Thaumalea johannis,** new species.

Rather small dark brown species with smoky wings. Last two palpal joints slightly shorter than flagellum. Scutellum with a single row of marginal setae. Legs dark brown. Subcosta complete, joining costa just before base of Rs. R_2 placed about four times its length from base of fork of radius sector. R_3 gently and evenly curved, its tip approaching R_{4+5}. Cu_1 gently curved forwards. Wings with villae only. Halteres and abdomen dark brown.

Male hypopygium. Ninth segment broad, covering the hypopygium, the paired flaps beyond it with short spine-like setae. Side piece conical, as broad as long, strongly excavate at tip for insertion of clasper, with coarse hairs outwardly and beneath. Clasper short, tapering, hairy, with about six terminal claws. Tenth sternites with triangular base, oblique, distinctly constricted before the tips.

Types, two males, no. 27461, U. S. Nat. Mus.; Cabin John, Maryland, March 24, 1915, April 14, 1916 (*R. C. Shannon*).

4. **Thaumalea elnora,** new species.

Entirely yellow, except for reddish brown abdomen. Last two palpal joints noticeably longer than flagellum. Scutellum with two irregular rows of setae. Sc-R cross vein before the middle of humeral cross-vein and tip of subcosta; subcosta ending beyond base of radial sector; R_2 about twice its length from base of R_{4+5}; R_3 rather strongly bowed and approaching tip of R_{4+5}; M-Cu cross-vein opposite base of Rs, two and a half times as long as R-M cross-vein. Wing faintly smoky. Halteres and cerci of female bright yellow.

Male hypopygium. Ninth segment broad, slightly more heavily chitinized than the preceding ones, the pair of flaps beyond it (tenth tergites) finely setose. Side piece conical, about as long as broad, sparsely and coarsely setose. Clasper conical, setose, with two claws at tip. Tenth sternites with triangular base, curved, long, thickened at tip and recurved in a hook.

Types, male and female, no. 27462, U. S. Nat. Mus.; Moscow Mountain, Idaho, July 25, 1920 (*R. C. Shannon*). Dr. A. L. Melander was the first to discover the habitat of this species.

It gives us pleasure to name this species for Miss Elnora M. Sutherlin.

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